

**ASSESSMENT AND ATTAINMENT OF COURSE OUTCOME AND PROGRAM  
OUTCOME FOR A COURSE IN TEACHING LEARNING PROCESS FOR EFFECTIVE  
OUTCOME BASED EDUCATION**

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### **Abstract**

Outcome based education is important as a part of effective Teaching-learning process required by National Board of Accreditation (NBA). This ensures that a graduate not only possesses a sound program specific knowledge but also can have excellent skills, proper attitude and behavior. To achieve 12 program outcomes (PO's) the University curriculum is mapped accordingly. Innovative Teaching-learning methods like flip classroom, Project based learning, Quiz Contest, and Activity based learning, Content beyond syllabus are used for effective understanding and learning experience of students. Different instructional methods pedagogical initiatives are used to teach each course. Academic framework for continual Improvement which includes PDCA (Plan, Design, Check and Act) is used for teaching learning process. Each course is designed with specific CO's and each CO is mapped to the PO. The attainment of CO's is quantified by assessing students [1]. Their performance is tabulated and analyzed using MS Excel software. The quantification methodology involves different attainment tools and detailed articulation wherein each question is mapped to a CO and its corresponding PO. Thus considering continuous internal evaluation data one can measure the attainment of CO and the PO for a batch of students. The level of attainment also can be easily varied based on the level of the course and efficiency of the student.

**Keywords:** Outcome based education, Course outcome, Program outcome, PDCA.

### **Introduction**

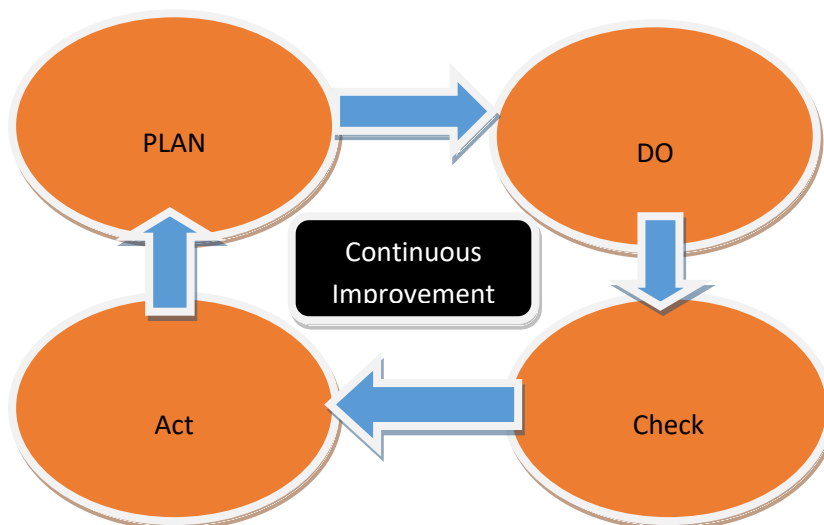
To ensure quality of higher education, the government of India is in process of making accreditation mandatory for technical institutions. In India, National Board of Accreditation (NBA) is the body responsible for accrediting the Technical Programs [2]. India has become the permanent member of Washington Accord from 13<sup>th</sup> June 2014; it has started accreditation on the basis of outcomes. Technical Institutions need to follow Outcome Based Education (OBE). This OBE model has potential to measure learning or the Course outcomes.

In view of employment becoming more and more challenging, attributes such as knowledge, skill, values, attitude must be given due importance. This calls for design of the whole educational process that enables graduates to meet the set goals. The students should successfully demonstrate these attributes at the end of program which comprise of many courses. Quality of teaching must be judged from quality of learning. Hence each program must have intended outcomes. In OBE, one of the main criteria is the attainment of Programme Outcomes (POs). The POs are formulated for each programme by the institute and must be consistent with the NBA's Graduate Attributes such as: i) Engineering Knowledge, ii) Problem Analysis, iii) Design/Development of Solutions, iv) Conduct Investigations of Complex Problems, v) Modern Tool Usage, vi) The Engineer and Society, vii) Environment and Sustainability, viii) Ethics, ix) Individual and Team Work, x) Communication, xi) Project Management and xii) Life-Long learning. These POs can be attained through Course Outcomes (COs).

For each course, course outcome statements are formed which have correlation with program outcomes. There must be a systematic and documented process in place for attainment of course outcomes which further contribute to attainment of program outcomes. Various steps in outcome based education are:

- Setting the objectives and outcomes
- Defining outcome based process
- Designing outcome based curriculum
- Outcome based delivery and learning
- Assessment and evaluation of outcomes

The OBE implementation is often considered as compliance-driven instead of performance-driven activity. The execution seems very structured on paper, but the implementation may involve daunting data collection process.



**Figure 1. OBE Framework**

Above Figure 1 shows that framework of Outcome Based Education (OBE). OBE is an educational process which is based on making an endeavour to achieve certain specified outcomes in terms of continuous improvement in student learning.

The three main objectives of an outcome-based approach to learning are:

- An explicit statement of learning intent expressed as outcomes–
- Approach to enable the intended learning to be achieved and demonstrated (curriculum, teaching, learning, assessment and support and guidance methods)
- Criteria for assessing learning aligned to the intended outcomes.

Course Outcomes (COs) are broad statements of what a student should be able to demonstrate upon completion of a course and are central to course's curriculum. Course Outcome (CO) is a measurable, observable, and specific statement that clearly indicates what a student should know and be able to do as a result of learning.

Each course outcome must be mapped to program outcomes PO's. The extent to which each CO correlates with respective PO can be expressed as low, medium or high. Collective COs for all courses in a curriculum must address all Pos. So, attainment of Program outcome plays vital role towards achieving Outcome Based Education (OBE). The methodology for attainment of Course Outcomes (CO's) [3] which leads to attainment of PO's is demonstrated in next two sections.

### **Attainment of Course Outcome**

Attainment process of COs comprises of gathering the data through different assessment tools and calculating attainment. Attainment calculation process of COs is divided into two parts:

1. Direct Attainment calculation
2. Indirect attainment calculation

Direct Attainment includes the internal and external assessment of each CO and Indirect Attainment includes views of stake holders correlated to CO in the form of course end survey. Figure 2 shows that CO-attainment process. Eighty percentage (80%) weightage is given to Direct Attainment and twenty percentage (20%) weightage is given to indirect attainment. Direct is divided into internal and external assessment which carries 20% and 80% weightage respectively. CO attainment is addition of direct and indirect attainment. If CO is attained then the target is revised for the next year else the gap is analysed in program assessment committee [4].

### 1) Direct Attainment

Assessment tools used to gather the data upon which the evaluation of course outcome is based is done in two parts:

1. Internal Assessment
2. External Assessment

The Internal Assessment tools such as Unit Tests, Preliminary Examination, Mock Orals, Assignment, TW, etc. are used at the Department level as per the Institute academic calendar. And the External Assessment is done at the university level. Assessment tools such as In-semester/Online examination, End semester examination, Practical-oral examination and Project/Seminar are used for external assessment. Assessment tools used to gather the data for Course Outcome direct attainment.

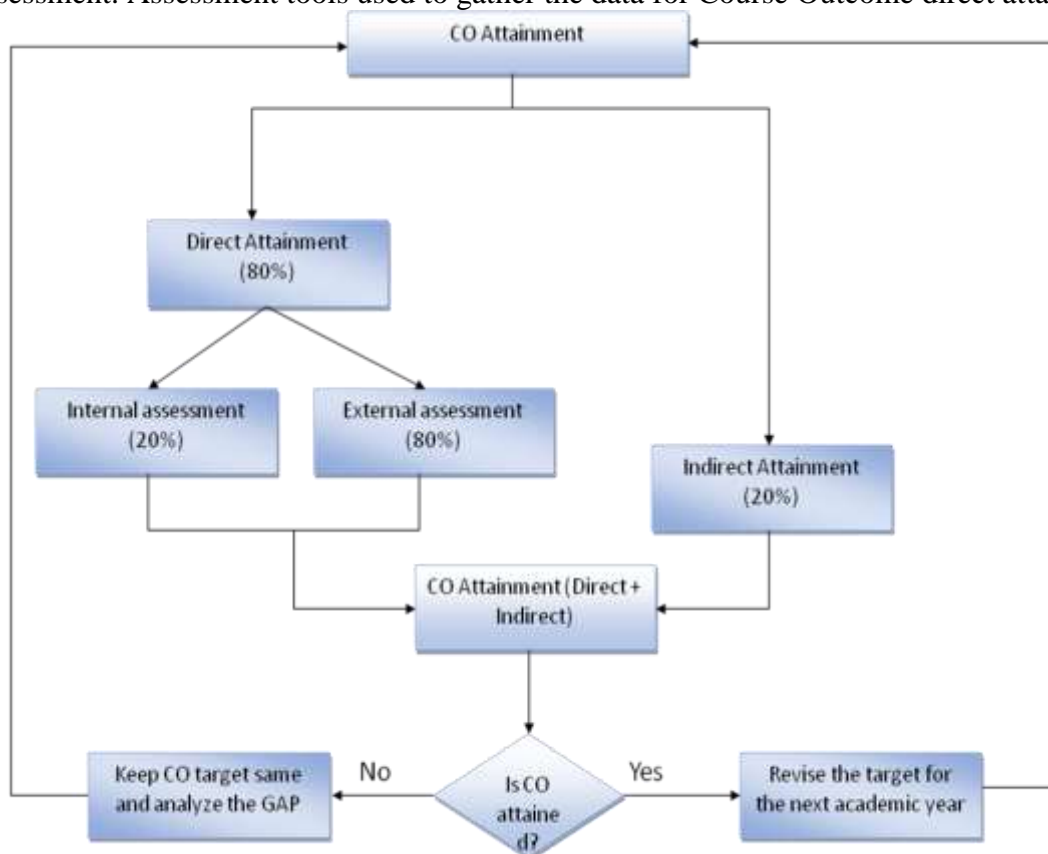


Figure 2. CO-Attainment Procedure

### Assessment Tools for Direct Attainment

#### Internal Assessment Tools:

It includes the assessment of each CO contributing towards attainment of PO. Twenty percentage (20%) weightage is given to internal assessment. The Internal Assessment tools such as Unit Tests, Preliminary Examination, Mock Orals, Assignment, TW, etc. are used at the Department level.

- 1) Unit Tests:

Two unit tests with maximum 30 marks are conducted for each course during the semester. Course teacher prepares class test question papers with the Bloom's Taxonomy Level for respective

course taking the reference of previous university question papers and question bank. Class tests are conducted as per departmental academic calendar. The course teacher evaluates the answer sheets as per model answer sheet and declares the result. The course teacher does the result analysis and calculates CO attainment.

2) Preliminary Examination:

Preliminary Exam is based on all units of the syllabus for the respective subjects of 70 marks for TE and BE, and 50 marks for SE. The course teacher prepares question paper according to Bloom's Taxonomy levels for the respective course, considering COs to be assessed through internal examinations. The course teachers evaluate the answer sheets. The course teacher does the result analysis and calculates CO attainment.

3) Mock Oral Examinations:

Mock oral examinations are conducted for all the courses. Course teacher notes down the marks of each student in assessment sheet. These marks are used to calculate CO attainment.

4) Assignment:

Course teacher prepares assignments considering all COs for respective course. Course coordinator verifies the question bank and suggests corrections if any. The course teacher conveys rubrics for assignments to students. The course teacher evaluates the assignments as per rubrics and suggests improvements to students, if any. The course teacher prepares the assignment analysis and calculates CO attainment.

5) Term Work:

Course teacher regularly assesses the laboratory manuals/tutorial assignments of students based on predefined rubrics. Based on the rubrics, marks are assigned to each experiment/tutorial. Course teacher notes down the marks of each student in continuous assessment sheet. These marks are used to calculate university term work and in turn for CO attainment.

**External Assessment Tools:**

It includes the assessment of each CO contributing towards attainment of PO. Eighty percentage (80%) weightage is given to the external assessment. Assessment tools such as In-semester/Online examination, End semester examination, Practical-oral examination and Project/Seminar are used for external assessment.

1) In-semester Examination:

In-sem exam for TE and BE is conducted as per the schedule. The In-semester examination is based on Unit I, II, and III of the syllabus for the respective subjects for 30 marks.

2) Online Examination:

Online exam for FE and SE is conducted as per the schedule. Online exam phase-1 is conducted based on units I and II for the respective subjects for 25 marks. Similarly online exam phase-II is based on unit III and IV for the respective subjects for 25 marks.

3) End Semester Examination:

End-sem exam is conducted as per the schedule. The end SEM exam for FE and SE is for 50 marks whereas the end semester examination for TE and BE is for 70 marks.

4) Practical and Oral Examinations:

Practical and/or oral examinations are conducted by the external and internal examiner as per the schedule.

5) Project Work Evaluation:

The project guide and project coordinator conducts timely project reviews as per the rubrics. External Project viva-voce is conducted for semester VII and VIII by the panel of examiners. Based on the viva-voce and the project work carried out by the group of the students, the marks are awarded to the students.

6) Seminar:

Seminar in the VI semester is conducted as per the schedule mentioned in Time Table. The seminar coordinator and seminar guides follow rubrics, which are set by the department for

evaluation of the seminar. It is evaluated by the internal examiner (seminar guide) and marks are submitted [5].

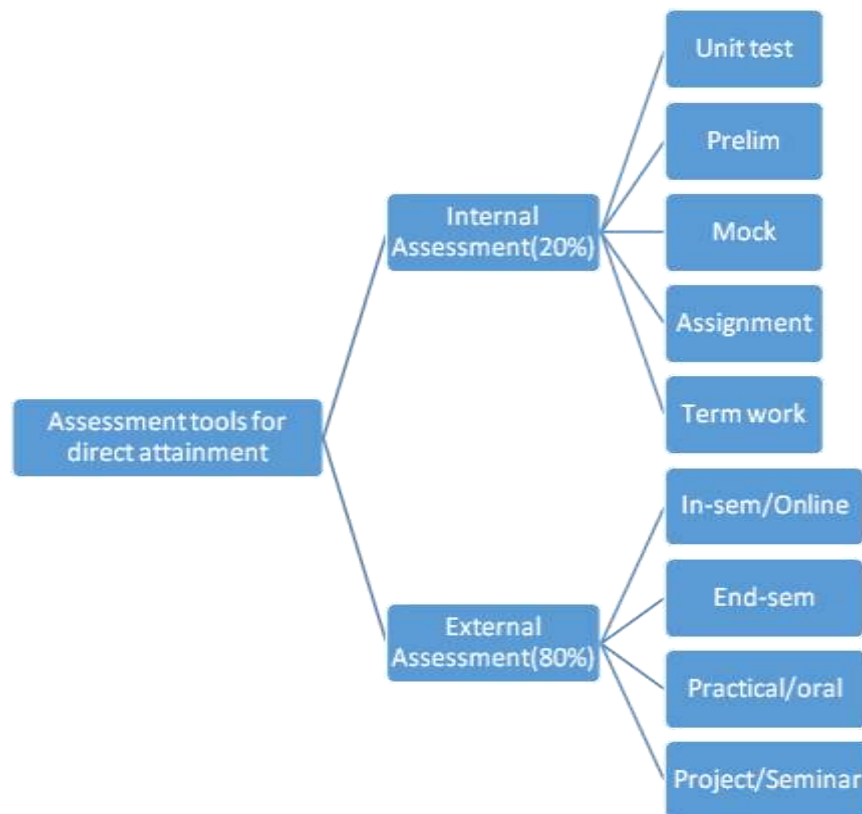


Figure 3. Assessment tools used to gather the data for Course Outcome direct attainment

**Measuring CO attainment through Internal/External Assessments:**

Attainment level of each assessment tool has been determined by categorising total no of students into four levels according to their performance in each assessment [4]. The four levels are as shown in Table 1. Level 0: If student scores less than 40%. Level 1: If student scores 40% to 49.99% marks out of the relevant maximum marks allocated for particular CO. Level 2: If student score 50% to 59.99% marks out of the relevant maximum marks allocated for particular CO. Level 3: If student score 60% and above marks out of the relevant maximum marks allocated for particular CO [6].

Table 1. Levels

Attainment Level	% Attainment Range
0	0 to 39.99
1	40 to 49.99
2	50 to 59.99
3	60 and Above

Attainment Level for a particular CO is calculated as below:

$$CO_i - \text{Attainment level} = \frac{\text{sum of level obtained by each student for a CO}}{\text{Total Number of students}} \tag{1}$$

Following Table 2 shows that attainment level with range of marks.

Table 2. Attainment Level

Criterion Range of Marks	(Assessment Tool) COi	
	No. of Students	Attainment
Marks >=60%	Xi	$=(X_i * 3) + (Y_i * 2) + (Z_i * 1)$ Total No. of Students
50 to 59.99%	Yi	
40 to 49.99%	Zi	

Marks < 40 % (failed)+Absent	F	-
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Following example in Table 3 shows sample for 10 students for a course 210. Two CO's (C210.1 and C210.2) of 13 marks and 12 marks each are used in the Unit test1. C210.1 level is the level of C210.1 CO and C210.2 level is the level of C210.2 CO. At the end, level wise attainment of respective CO's [7].

**Table 3. CO Attainment**

Sr. No.	Roll No.	Name of Student	C210.1 (13 M)	C210.2 (12M)	C210.1 Level	C210.2 Level	Total
1	S31401	N1	3	0	0	0	3
2	S31402	N2	0	0	0	0	0
3	S31403	N3	3	2	0	0	5
4	S31404	N4	4	4	0	0	8
5	S31405	N5	6	6	1	2	12
6	S31406	N6	0	0	0	0	0
7	S31407	N7	10	7	3	2	17
8	S31408	N8	10	7	3	2	17
9	S31409	N9	5	5	0	1	10
10	S31410	N10	10	11	3	3	21
.....	.....	.....	....	....	....	.....	....
		CO Attainment			1.19	1.48	

Similarly attainment for all internal tools is calculated and the mean of all tools for respective COs is calculated as follows.

$$CO_i - \text{Internal Attainment level} = \frac{\text{sum of attainment of all internal assessment tools}}{\text{Number of assessment tools}} \quad (2)$$

Following example in Table 4 shows the Internal attainment for course 210. The attainment is calculated using the above equation.

**Table 4. Internal Attainment**

Internal Attainment							
CO	UT1	UT2	Prelim	Assignment	MOCK	TW	Mean
C210.1	1.19		1.52	1.92			1.54
C210.2	1.48	2.39	0.91	2.16	2.63	3.00	2.09
C210.3			0.87	2.48	1.96	2.97	2.07
C210.4			0.96	2.48	2.67	3.00	2.28

Similarly attainment for all external tools is calculated and the mean of all external tools for respective Cos is calculated as follows.

$$CO_i - \text{External Attainment level} = \frac{\text{sum of attainment of all external assessment tools}}{\text{Number of assessment tools}} \quad (3)$$

Following example in Table 5 shows the External attainment for course 210. The external attainment is calculated using the above equation [8].

**Table 5. External attainment**

External Attainment				
CO	InSem	EndSem	EXT. OR	Mean
C210.1	2.33	1.91		2.12
C210.2	2.41	1.85	2.17	2.15
C210.3		1.79	2.09	1.94
C210.4		1.79	2.31	2.05

Finally the CO Direct attainment is calculated using following equation:

$$CO - direct\ attainment = (0.2 \times CO - internalattainmentlevel + 0.8 \times CO - externalattainmentlevel) \quad (4)$$

Following example in Table 6 shows the CO attainment for course 210.

**Table `6. Course Attainment**

	20%	80%	Total
	Internal	External	
C210.1	0.31	1.70	2.00
C210.2	0.42	1.72	2.14
C210.3	0.41	1.55	1.97
C210.4	0.46	1.64	2.09

## 2) InDirect Attainment

Attainment process of COs is divided into two parts - Direct Attainment and Indirect attainment through course end survey. The Course End Survey is considered as an indirect assessment tool in course. 20% weightage is given to course end survey and 80% weightage is given to direct course attainment done using above mentioned tools. Course end survey is taken as a survey from students for every course. Calculation of attainment of CO's using data collected through course end survey is [9]:

$$CO_i = \frac{\text{Sum of responses for CO}_i}{\text{Total number of students}} \quad (5)$$

Following Table shows that the course end survey for course 210 under indirect attainment.

**Table 7. Course End Survey**

Course End Survey	
C210.1	3
C210.2	2.98
C210.3	2.7
C210.4	3

Finally the CO attainment is calculated using following equation:

$$CO - attainment = (0.8 \times direct\ attainment + 0.2 \times indirect\ attainment) \quad (6)$$

Following Table 8 shows that the final attainment for course 210 with 80% direct and 20% indirect attainment.

**Table 8. Final Attainment**

	80%	20%	Total
CO	Direct	Indirect	
C210.1	1.60	0.6	2.20
C210.2	1.70	0.59	2.30
C210.3	1.57	0.54	2.11
C210.4	1.67	0.6	2.27

The Course outcome for the course 210 is 2.22. The target set for this course was 2.10 (70% of 3). The target is achieved and will be revised for next year to 2.25 (75% of 3) [10].

Attainment of Program Outcomes for a Course:

Calculation of attainment of Program Outcomes for a course is done using following equation.

$$PO_i \text{ Attainment} = \frac{[(CO_1 \text{ Attainment} * CO_1 \text{ Mapping to } PO_i) + (CO_2 \text{ Attainment} * CO_2 \text{ Mapping to } PO_i) + \dots \dots]}{3 * \text{No. of } COs \text{ Mapped to } PO_i} \quad (7)$$

Following Table 9 shows PO attainment for course 210.

**Table 9. PO Attainment**

CO	80%	20%	Total	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO
	Direct	Indirect		1	2	3	4	5	6	7	8	9	10	11	12
C210.1	1.60	0.60	2.20	2	-	-	-	-	-	-	-	-	-	-	-
C210.2	1.71	0.60	2.30	3	3	2	-	-	-	-	-	-	-	-	-
C210.3	1.57	0.54	2.11	2	2	-	-	-	-	-	-	-	-	-	-
C210.4	1.67	0.6	2.27	-	-	3	-	3	-	-	-	-	-	-	-
PO attainment				1.73	1.86	1.91		2.27	-	-	-	-	-	-	-

On the similar lines, at program level above procedure of course outcome and program outcome attainment can be carried out. The program outcomes which are remotely attained forms the basis for planning of action for continuous improvement in the subsequent years.

### Conclusion

The work presented in the paper proposes a method based on assigning attainment levels for every assessment tools of a course and their mapping with CO's. One of the key aspects in the process of CO attainment is fixing the target value. The proposed method takes into account the major population of students for setting the target. The paper basically focuses on direct as well as indirect attainment of Course Outcomes based on which attainment of Program Outcomes can be measured. The program outcomes which are remotely attained forms the basis for planning of action for continuous improvement in the subsequent years.

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